A REVIEW OF THE NATIONAL ACADEMY OF SCIENCE

WORLD FOOD AND NUTRITION STUDY

UNITED STATES DEPARTMENT OF AGRICULTURE

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A REVIEW OF THE NATIONAL ACADEMY OF SCIENCE

WORLD FOOD AND NUTRITION STUDY

BY THE RESEARCH STRATEGY GROUP OF

THE AGRICULTURAL RESEARCH POLICY ADVISORY COMMITTEE (ARPAC)

WASHINGTON, D.C. ISSUED AUGUST 1978

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FOREWORD

The 1974 World Food Conference in Rome studied world food problems, particularly in production, preservation, storage, and distribution of food. President Ford then requested the National Academy of Science (NAS) to assess food problems "and develop specific recommendations on how our research and development capabilities can best be applied to meeting this major challenge."

The World Food and Nutrition Study (WFNS), released by NAS in June 1977, was prepared by the Steering Committee, National Research Council Study on World Food and Nutrition. Research priorities and organization were suggested by 14 study teams consisting of prominent scientists and research administrators from universities, industry, government, and foundations in the fields of agriculture and nutrition. The members of the study teams also sought views from researchers in all areas of the world.

At its July 1977 meeting, the Agricultural Research Policy Advisory Committee (ARPAC) instructed its research strategy group to assess recommendations of the WFNS in relation to research needs and priorities expressed through ARPAC or in recent studies by others.

This research strategy group formed four subcommittees corresponding to the four major research areas of the WFNS: (1) Nutrition, (2) food production, (3) food marketing, and (4) policies and organizations.

The subcommittees were requested to review their area of concern and comment and discuss (1) priorities listed, (2) results expected, (3) effects of planned research, (4) sources of funding, (5) international framework, and (6) recommendations for U.S. action. Each group was also asked to recommend initiatives ARPAC should take to achieve overall objectives of the WFNS.

The WFNS and subcommittee reports were presented to and discussed by ARPAC in November 1977. ARPAC was in general agreement with the WFNS and commended it to agencies and institutions of the agricultural research community as an excellent identification of problems and research needs. ARPAC also accepted the subcommittee reports and requested that they be published and transmitted to the Joint Council on Food and Agricultural Sciences and the National Agricultural Research and Extension Users Advisory Board authorized by Title XIV, Food and Agriculture Act of 1977.

We wish to call attention to important comments or recommendations of the subcommittees. The subcommittee on policies and organizations has summarized an implicit model on which the WFNS is founded. This implied model directly affects the kinds of research and support for research in the United States and other countries. A world model internalizes factors that are external in terms of U.S. decisions. Domestic programs cannot exercise significant control over policies, social factors, and institutional arrangements in other countries.

Title XIV of the Food and Agriculture Act of 1977 establishes the U.S. Department of Agriculture as lead Federal Agency for food and agricultural

science and emphasizes that agricultural research, extension, and teaching are distinct missions of USDA. This provides an alternative to WFNS recommendations to perform this function in the Executive Office of the President.

The nutrition subcommittee recognizes that a limited number of professionals have expertise to conduct research in human nutrition closely with counterparts in developed countries on surveys and assessments involving human subjects. Much research in dietary components will need to be conducted in developed countries where facilities and expertise are concentrated. The nutrition subcommittee also recommended changes in the national and regional research planning, projection, and classification system for greater emphasis on food and nutrition.

The food production subcommittee is concerned that results expected in basic biology in the short run may be overemphasized and that facility needs for both fundamental and applied research are underemphasized.

At its meeting on April 27, 1978, the Joint Council on Food and Agriculture Sciences received and endorsed this report and authorized its publication. We commend the subcommittee reports for study and have provided a digest that indicates major suggestions and recommendations from each subcommittee.

James M. Beattie
Cochairman

Kenneth R. Farrell
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CONTENTS

I. DIGEST 1/

In this section, brief summary statements are given for those points on which the four subcommittees supported or challenged the conclusions of the World Food and Nutrition Study (WFNS). This digest includes material on some points not treated by all the subcommittees since some areas of the review specifically were assigned to only one subcommittee. Thus, the following reports must be read thoroughly to understand the reaction to the WFNS.

A. General Comments

The WFNS presents a comprehensive and generally balanced view of the world food and nutrition problem and potential for research. Behind this view is an implicit model that may oversimplify problems of food and nutrition. This model implies a level of nutrition to be met or exceeded by all people. It assumes that the world's capacity for agricultural research can meet this need. Currently, some nations already have levels of nutrition far above that which could be a reasonable goal for many nations and have research programs to raise that level. There is a need to bridge the gap between the goals of the model and current conditions.

The WFNS was commended for recognizing social, political, cultural, and economic factors that prevent the realization of nutritional goals. On balance, however, less attention was given to these factors than to the more tangible biological science ones.

Considerable dependence is placed on basic biology and other fundamental approaches. These are "longrun" investigations that cannot give a high assurance of useful results in the relevant time span. Emphasis on adaption and application of known technology are needed in the short run. There is also a need for more traditional types of research that will improve efficiency in the next 25 years.

Problems in marketing farm products and inputs did not obtain the attention deserved. This was particularly true of problems related to the handling of products after they left the farm.

B. Priorities

The subcommittees generally agreed that research priorities given in the WFNS were appropriate. In addition, the subcommittees added a few priorities not in the WFNS.

The range of research in the study may have been restricted unintentionally. For example, all plant biology research is covered under the categories of biological nitrogen fixation, photosynthesis, and environmental stress. A broader definition in the context of the study would be appropriate. Emphasis on work with animals was suggested for "small ruminants" whereas "small food animals," which would include such nonruminants as swine, poultry, rabbits, and

1/ Prepared by Robert F. Hutton, SEA principal agricultural economist, and Melvin R. Janssen, ESCS agricultural economist.

guinea pigs, seems more appropriate. Emphasis upon the ruminant may have been proposed on the assumption that it is noncompetitive with humans. Many nonruminants, however, also can be used as scavengers that are noncompetitive with human needs.

An area not explicitly identified in the research priorities was that related to drainage and salt balance management. This important problem for many developing countries (DC's) was given much less emphasis than it deserves.

C. Results To Be Achieved

The WFNS projected the expected results of its proposed research and, in most instances, also estimated the time at which benefits were to be expected. The subcommittees generally agreed with these study projections. The following are some qualifications.

The high level of uncertainty associated with timing of results and ultimate payoff for human nutrition research was noted by the reviewers. The WFNS projections may be optimistic in this regard.

The WFNS may imply a greater role for U.S. scientists working in the developing countries than is reasonable. High cost, tax disincentives (double taxation), and political acceptance are some barriers to be overcome. Without such participation by U.S. scientists in the developing countries, the rate of progress probably will be slowed substantially.

D. Expected Effects

The projection of a fourfold increase in production in the humid tropics, suggested by the WFNS in a 10- to 15-year span, may not be attainable without some dramatic "breakthrough" that cannot be counted upon. Substantial progress can be made, however, and is worthy of the emphasis given to it. More time than projected probably will be needed.

The WFNS emphasized a program of research to solve the world's food and nutrition problems. Only incidental recognition was given to problems of trade, food reserves, and nutrition not amenable to solution by research. In effect, the WFNS assumed that these problems would be solved at a pace that would allow application of the solutions to the researchable problems. To the extent that this is optimistic, the pace of progress will be slower than the WFNS anticipates.

E. Sources of Support

The WFNS identified what it considered to be reasonable sources of support for each major area of research. For the most part these sources were Federal Agencies that would be responsible for some or all of a particular research problem area. Where more than one Agency was named, one was designated as the lead Agency. The subcommittees basically agreed with the WFNS assignments. Suggestions are given for exception or extension of these assignments.

The WFNS indicated the Environmental Protection Agency (EPA) as a possible source of support for biological nitrogen fixation research. The subcommittees visualize only a peripheral role for EPA in this area.

The Departments of State, Commerce, Defense, Treasury, Energy, and possibly Transportation are involved in what should be researched in trade and reserves-related food and nutrition policy. These Agencies will not take part in the research nor give financial support to it but should not be overlooked in planning and doing the work since they will be involved in implementing the results. The WFNS recognizes this contribution in Appendix D.

F. Recommendations for International and U.S. Action

The WFNS presented an extensive set of recommendations for actions that were considered in detail by the subcommittees. All subcommittees essentially agreed with these recommendations, which are in the individual reports. Only major exceptions and qualifications are indicated here.

The WFNS calls for an Assistant Secretary of Agriculture for research and education. This Assistant Secretary would have the economic research arm of the Department under him as well as the traditional units (SEA). Since the WFNS was issued, the Food and Agricultural Act of 1977 has become law. In response to this act, changes have been made in the structure of the Department. The subcommittees suggest that these changes be tested before further changes of the type suggested by WFNS are sought.

The WFNS proposes to expand support for present USDA research programs and advocates a strong competitive grants program targeted at priority needs identified in the study. The subcommittees support the WFNS position of a grants program with a strong peer review system that is separated from the priority setting activity under the program. Concern was expressed for maintaining the institutional programs in competition with the competitive grants program. The WFNS is only one of several recent studies that call for expanding agricultural research; however, research budgets have not noticeably increased.

Grants for facilities were proposed by the WFNS to permit the initiation of agricultural research by institutions not now engaged in such work. The subcommittees agree to the need for these facilities, both in the institutions now doing research and those that will initiate work under the competitive grants program. The provision of funds for facilities implies a continuing relationship, however, that cannot be assured under a competitive grants program. Thus, the subcommittees suggest that another means be used to meet this need, possibly funds for facilities within the competitive grants program.

The WFNS suggests that AID strengthen its efforts to train research personnel in developing countries. The subcommittees hold that Title XII of the International Development and Food Assistance Act of 1975 (PL 94-161) is an appropriate vehicle for such a program. They further suggest that the "international universities" including the "U.N. University" be utilized.

The WFNS recommended establishment of two entities in the Executive Office of the President. The first would "develop and maintain a coherent U.S. strategy for dealing with world food and nutrition problems" in relation to other activities. The second, a subordinate group, would "facilitate coordination of U.S. and international research activities on food and nutrition."

These recommendations were published before the Food and Agriculture Act of 1977 (PL 95-113) became law. This act created the Subcommittee on Food and Renewable Resources of the Federal Coordinating Council for Science, Engineering, and Technology, which apparently has some functions envisioned in these recommendations. In addition, this act assigned some coordinating functions that were recommended for the Executive Office to the Secretary of Agriculture.

The WFNS expressed concern that privately sponsored research was not being used to the optimum degree. To further encourage such research, it recommended that regulations affecting research and development in food and nutrition be better coordinated and simplified. The WFNS also recommended that attention be given to protecting the property rights of findings from such research. This is a problem that has both U.S. and international aspects. The subcommittees supported both these recommendations.

Recommendations to ARPAC

All subcommittees strongly recommended that ARPAC endorse the WFNS and urge the USDA and State experiment stations to expand research on undernutrition and inadequate food production and consumption in developing countries.

The roles of agencies associated with ARPAC in research programs related to international food and nutrition policies need to be defined and documented. The recommendations are at the end of each subcommittee report.

II. NUTRITION

A. *Do the priority areas in the WFNS represent appropriate problems that should be addressed to meet world food and nutrition needs in the next few decades? If not, suggest additions or alternatives.*

We believe the 22 priority areas represent important problems that can and should be dealt with through additional research. The four priority areas dealing specifically with nutrition (nutrition-performance relations, role of dietary components, policies affecting nutrition, and nutrition intervention programs) and certain of the more closely related areas (food marketing and policies and organizations) provide a comprehensive framework for a global nutrition research program. The WFNS suffers because of diffuse scope. We feel that practical limitations on time, manpower, and funding may dictate that worldwide nutrition research be limited to a smaller scope or focused more specifically than suggested by the WFNS. We believe that the Federal-State agricultural research system could make a particularly valuable contribution to the international nutrition program by concentrating its resources on problems such as better use of PL 480 funds, integration of health and nutrition programs, food composition and bioavailability of nutrients, effects of protein/energy and specific nutrients on nutritional status, and utilization of food processing technology in developing countries.

B. *Will the nature of suggested research described in chapter 2 and summarized in table 3 of the WFNS achieve the desired results? Do other alternatives hold greater promise for achieving the desired results?*

We believe the proposed nutrition research can achieve the intended results, although the proposed research on performance relationships is, in our view, extremely difficult and will require a well planned and coordinated effort to be effective. We suggest that special emphasis be given to research with human subjects whenever feasible and that research be tied to practical intervention programs to the extent possible. Much of the research on nutritional requirements and food properties can be done through use of animal models; the research then can be translated in human terms. The problem is to decide when enough information exists to relate to the human model usefully. We also feel that the areas of policies affecting nutrition are quite complex and care should be exercised in designing research to assure that new information will be relevant and practical.

C. *Are the major effects of planned research realistic?*

The potential effects of planned research in nutrition are stated in optimistic, but realistic, terms for the total outcomes. These statements are realistic in that they recognize that the long-term effect is difficult to estimate, knowledge needed is of many types and interrelated, additional personnel in both the United States and developing countries are essential, and policies and decisions by the governments on support for the long-term programs will affect the outcomes. If potential effects are to be attained, our best efforts and strong leadership will be necessary.

D. *Are appropriate sources of support identified? Should a lead source be identified in each case?*

Sources of support are appropriately identified from the public sector. No mention is made of potential private sector (industry) support, however, although this need is identified in chapter 3, "How to Get the Work Done."2/ Whatever the particular source, we feel the need for strong and stable funding for human nutrition research in keeping with the idea that human nutrition and food research is identified as a major area of emphasis.

Title XIV, Section 1403 of the National Agricultural, Research, Extension and Teaching Policy Act of 1977 (PL 95-113), establishes USDA as lead Agency in the Federal Government for the food and agricultural sciences, which include human nutrition. Section 1423 (a) establishes research in food and human nutrition as a separate and distinct mission of the Department. Other than this designation, we feel no lead or coordinating agency designations generally should be made. We do not feel it feasible to list the sources in potential contribution or priority.

E. *Assess the three major conclusions relating to "the international framework," identified on pages 128 to 133, that are related to your subcommittee subject-matter area.*

These three conclusions are generally sound. However, none of the centers supported by the Consultative Group on International Agricultural Research (CGIAR) deal specifically with human nutrition. Therefore, support to these centers would not be expected to result in outputs directly concerned with nutrition. This does not mean that a new nutrition center is required since there are many reputable nutrition research centers where additional research might be undertaken with U.S. support.

> Research will have to be carried out in the developing countries with need for enlargement of their capacity to do the research. (p. 128)

Because of the current limited number of people with professional expertise in human nutrition throughout the world, including the United States, there are problems and limitations in carrying out this recommendation. Experts in the developed countries will need to work closely with their counterparts in the developing countries on the surveys and assessments needed involving human subjects in the nutrition performance area. Much research in the dietary components area will need to be conducted in the near term--as this is where the needed facilities and expertise are concentrated. The developing countries can work effectively in improving and assessing the effects of nutrition intervention programs.

2/ See summary of conclusions concerning the International Framework on pages 18 and 19.

Chapters, sections, and page numbers mentioned in this publication refer to the WFNS.

Research on the nutritional properties of local and regional food should be carried out in the developing countries or regions. Assessment of nutritional problems and continuing surveillance of nutritional status and the effectiveness of interventions also should be carried out in the developing countries. Support from the United States through (1) training researchers and specialists, (2) establishing research and training institutions and facilities, and (3) collaborating in research will be necessary. In addition, the development of information resources and their effective use should be a high-priority item in all institution building programs in developing countries. One of the greatest wastes in science is the wasted effort in misdirected research due to lack of awareness and contact with world literature among researchers in developing countries.

The WFNS indicates the need for increased social science research related to nutrition, yet the discussion touches briefly on the role of the social sciences in understanding the food habits and consumption patterns of people (pp. 67 and 133). Unless this problem is solved, all other efforts will be wasted.

> International research centers concerned with food and nutrition research should be extended and strengthened. (p. 128)

This does not seem to apply to most of the nutrition area because of the very limited effort of these centers in basic nutrition. The centers could enlarge their programs in improving the nutritional quality of crops and in diagnosing mineral nutrient deficiencies in soils.

The international agricultural research centers have made very significant contributions through multidisciplinary research intensively focused on a specific set of targets in a single crop or system. Flexibility to restructure research teams to attack other problems is very desirable. The restructuring could encompass research in human nutrition.

Utilization of the centers for training scientists at the postdoctoral level is highly desirable. There would be advantages and merit in having an international research center affiliated with a university or group of universities.

> A large part of the research, especially basic, will have to be done in the developed countries. (p. 128)

There is some disagreement about this conclusion. The knowledge gained from basic research is universal, and developed countries generally have facilities and personnel trained and working in basic research. Adaptation of the knowledge and some of the fundamental research needed in human nutrition can be accomplished in the developed nations, but we do need to increase the training of representatives from underdeveloped countries. We have trained many from the developing nations, but these individuals generally do not return. Positions must be made available in the home country for trained individuals if their knowledge is to be useful in answering world food and nutrition problems.

F. *Reactions to "Recommendations for U.S. Action"*

It is extremely difficult to deal with recommendations on comparative roles. Perhaps it would be possible to define new initiatives and give new charges for U.S. action with regard to human nutrition, with the intent of enlisting coordination of other agencies capable of dealing with the problems.

The Federal Agencies need to take a longer view of nutrition research, here and abroad. This future-oriented vision should be accompanied by commitment to continuity of funding. These actions and attitudes are needed to attract and hold highly qualified people in human nutrition research and education.

Reactions to the recommended individual roles are:

1. Federal-State system:

The WFNS recommended:

> ...substantial increases in federal funding (1) for the traditional USDA research programs (including support for state programs), and (2) to establish a program of competitive grants for research on food and nutrition. (p. 135)
>
> ...a first-year increase on the order of $120 million, something under 20 percent of the total of about $700 million of USDA and state funds now devoted to food and nutrition research. We propose that the new funds be divided equally between the existing federal-state channels and the new competitive grants program. Thereafter, we recommend successive increases, after adjustments for inflation, on the order of $60 million or approximately 10 percent per year in real terms for the next four years, also divided evenly between the existing programs and the new competitive grants program. (p. 136)

There is general agreement with the recommendation for increased USDA effort and Federal funding--though some subcommittee members have reservations about the traditional funding patterns to USDA (which have not favored nutrition research) and about the formula funding procedure, emphasizing the need for specific commitments to and controlled use of funding for human nutrition research. There is endorsement of the competitive grants recommendation, with concern that this grants program should embody a strong peer review system as recommended by the WFNS. (p. 137)

2. Agency for International Development (AID): 3/

The nutrition subcommittee generally agrees with the recommendations but has concerns about the effectiveness of AID due to its current low level of

3/ Recommendations are summarized on p. 21.

staffing in nutrition. However, there should be an additional recommendation calling for close coordination of AID activities with the Title XII program and USDA.

3. National Institutes of Health (NIH):

Recommendations for NIH include:

> ...NIH support for nutrition research be reoriented to place greater emphasis on studies of human subjects, particularly using epidemiologic approaches and behavioral and other social science skills. (p. 145)
>
> ...more effective arrangements be established for coordinating research on nutrition supported by the several Institutes and by other relevant agencies in the Department of Health, Education, and Welfare. (p. 145)

We feel that the first two recommendations should be reviewed in light of the PL 95-113 declaration of Departmental responsibilities for nutrition research. We do not feel it is our prerogative to comment on the third recommendation concerning redirection within NIH and "only modest increments" in funding.

4. National Science Foundation (NSF):

We generally agree with the recommendations--to the extent that they are consistent with the nutrition research declarations in the Food and Agriculture Act of 1977.

5. Privately supported research:

> ...coordination and simplification of regulations affecting research and development on food and nutrition... (p. 149)
>
> ...evaluation of U.S. and international proprietary rights... (p. 150)

We concur and strongly endorse the recommendations. Coordination and simplification of regulations affecting research and development (R&D) and clarification of patent and proprietary rights are needed for more effective participation by the private sector.

G. *What initiatives do you recommend be undertaken by ARPAC for achieving the overall objectives of the WFNS?*

It is recommended that:

1. ARPAC endorse the WFNS and urge that USDA and the State agricultural experiment stations expand research activities to deal specfically with problems of

undernutrition and inadequate food production and consumption as they exist in developing countries.

USDA and affiliated State institutions have contributed substantially but indirectly to the solution of world problems of hunger and malnutrition through their domestically oriented research programs. However, they have had only a secondary role. We agree with the WFNS conclusion that the U.S. Federal-State system of agricultural research should be utilized directly and in force to help solve critical overseas problems. To accomplish this, we believe there is need for both a reorientation of focus within the Federal-State system and a substantial increase in funding along the lines proposed by the WFNS.

2. ARPAC propose accelerated implementation of Title XII so that university research capabilities can be directed more effectively to international food and nutrition problems.

Title XII provides a sound basis for use of U.S. university resources to help solve problems of inadequate food supply and consumption in developing countries. For various reasons Title XII has been very slow in developing and has not yet been set in full motion. Actions should be taken to identify the barriers to use Title XII and means found to implement this potentially effective legislation.

3. ARPAC change the regional and national agricultural research planning, projection, and classification system to provide greater identity for food and nutrition.

The planning system should be examined; as presently constituted and operated, research concerned with human problems has little opportunity to surface and be given priority status in the search for funding. The classification system is a mechanism for coordinated planning of research in the U.S. Department of Agriculture (USDA) and the National Association of State Universities and Land Grant Colleges (NASULGC). The research information recorded in Current Research Information System (CRIS) is the information component of the classification upon which much of the research and budget planning is based. There are continual requests for identification of food and nutrition research into rather discrete categories. This is a time-consuming activity, and the results are limited and possibly inaccurate because scientists and administrators involved with the research do not do the classification. A revision of the classification system will make possible accurate, complete classification of information.

4. ARPAC consider revising the CRIS system to make it possible to retrieve more readily research project information on nutrition and food research that is clear and mutually exclusive.

The present system of coding for CRIS results in an overlap of information that virtually makes retrieval of discrete information an impossibility. Therefore, it becomes necessary to hand sort projects and perform manual calculations if the information is to be useful as a planning base.

5. ARPAC take the initiative in responding to human nutrition-related aspects of Title XIV of the Food and Agriculture Act of 1977.

The WFNS contains information that relates closely to the Food and Agriculture Act of 1977. Human nutrition has been a top priority subject for several years but has received little support during budget development. The act (PL 95-113) also reflects congressional thinking and action. ARPAC should take the lead to support and fund high-priority research as identified in the WFNS.

6. ARPAC develop coordinated nutrition research projections and plans for the next 5- to 10-year periods to bring about realization of the lead agency role declared by Title XIV of PL 95-113. These efforts should be along the lines of the WFNS except as we have noted desirable modifications and adjustments in responses to questions 1 to 6.

7. ARPAC promote coordination of FY 1980 budget requests for nutrition research.

8. ARPAC work with appropriate associations and groups to promote greater involvement of private sector agricultural and agribusiness groups in food and nutrition (R&D) in the developing countries. ARPAC also should promote closer cooperation and coordination with the private sector in domestic food and nutrition (R&D).

III. FOOD PRODUCTION

A. *General Reactions:*

The WFNS presents a comprehensive and generally balanced overview of the world food and nutrition problem of coming decades and the potential contributions of research to that problem. Clearly, the task of doubling food production and delivery and of upgrading nutrition worldwide over the next 25 years demands our best efforts. Much of the technical input will be demanded from the United States and other developed-country resources.

We note the following general concerns as to the tone and content of the report:

1. It seems to us that research in the plant sciences, especially in basic biology, and perhaps fundamental research in general are not likely to provide solutions in the shortrun (25-year) time frame. We fully concur that fundamental research must be given increased attention, including funding of nontraditional sources of expertise. We hope that the WFNS does not imply that the pragmatic research system of this country has failed in the past, although it is clear that there are some weaknesses and much remains to be done.

We wonder if facility needs are underemphasized both for fundamental and applied research. Most of the shortrun (25-year) needs will be met through applied research. Facility improvements, both in the United States and abroad, will be needed to succeed in those efforts.

2. Further, we agree that funding of facilities and programs in institutions outside the current system is needed. Funding of such facilities and programs should carry a continuing commitment for involvement and contribution over time.

3. Although not our area, we believe that research on socioeconomic, religious, cultural, and political concerns is underemphasized. Much that is known cannot be applied in the poorer countries because of socioeconomic-religious-cultural-political hangups. The greatest gains over the next 25 years might be achieved through successful research and its application in this area. The highest research priority for food and nutrition in developing countries could well be "the development of systems for the application of knowledge on food and nutrition."

4. The WFNS stresses the need to coordinate research planning through the four categories--nutrition, food production, food marketing, and policies and organizations. Yet, little recognition is given in the food production research priorities to specific food and nutrition needs of people. No requirement is made that the sensory, nutritional, processing, storage, potentially toxic, and other food quality attributes are an essential component of production research and planning. Also, nutritional needs should be expressed in terms of potential food supplies. What part can food processing play in the delivery of raw food ingredients through a storage and distribution system into acceptable foods?

Food production should recognize all of the additional inputs necessary to make food available in the home and marketplace. Getting increased production is irrelevant unless it results in an adequate food supply that is useful to consumers. Those concerned with the four categories must plan together and work for adequate support for all segments so each can perform its functions.

5. One of the most constructive steps possible for this country's involvement would be to bring much improved agricultural expertise to the principal agencies concerned with international programs. In particular, we agree that special attention to provision of strong agricultural expertise in AID is essential.

B. *Response to Food Production Recommendations:*

The subcommittee has reviewed the 10 food production areas in the WFNS. The following responses apply to the four questions posed by the Research Strategy Group individually for each area.

1. Plant breeding and genetic manipulation (p. 71)

   a. This is clearly a high-priority research area. Over the past 50 years very substantial improvements have been made in many plant species through breeding. Many species should continue to respond to improved plant breeding and genetic techniques during the next several decades.

   b. Will suggested research achieve the hoped for results? As indicated under (a), plant breeding and classical genetics, while being both short- and long-range research, should contribute to accomplishing the desired results. The current breeding systems and newer techniques are paying off and should continue to be supported. The work under cell biology is of longer range. The objectives to produce genetic changes at the cell level, to stabilize these changes in the whole plant, and to develop new methods of screening germplasm for agronomically important traits are very worthwhile, long-range objectives. It is still early to forecast the impact and timing of results of this new approach to plant improvements, though some believe results may be available in 10 to 20 years. Genetic stocks continue to be an important aspect of plant improvement. Resistance to environmental stresses should be considered along with plant breeding. If kept separate, it is only to emphasize the importance of these approaches.

   c. Are the major effects of planned research efforts realistic? Within the framework of time and funding, major accomplishments are realistic expectations on several crop commodities, including pasture and forage species, vegetables, and fruits.

   d. Sources of support. USDA, as lead Agency, should be supported both for intramural and extramural research. This Agency has carried a heavy load in plant improvement work over the past 50 years and

should continue as the lead source. AID support for plant breeding work on an international basis should be maintained and strengthened. International centers are playing a very important role in plant breeding and genetic work, and they should be supported by the U.S. program. We agree that the National Science Foundation (NSF) should increase fundamental research on biology and other natural science disciplines. All of these agencies must lend support to training of scientists, particularly in interdisciplinary research. The suggestion that AID and USDA make more use of competent research capabilities of private enterprise should be encouraged even though in plant breeding, contract work is probably not as feasible with private resources as in some other areas of food and nutrition.

2. Biological Nitrogen Fixation, Photosynthesis, and Resistance to Environmental Stress (pp. 74-80)

   a. These three areas of more fundamental research are worthy of expanded attention, although payoffs are most likely in the long run. Clearly, fertilizer nitrogen is not and will not be available to incorporate into food production systems in the developing countries where the problem is most acute, and in the long run we must crack the nitrogen fixation problem. Similarly, in photosynthesis, room for improving efficiency and research into basic aspects of that phenomenon hold promise for long-term improvements. Enhancement of the resistance to environmental stress in plants and in animals could improve production efficiency significantly and is an area worthy of further investigation.

      These three areas of more fundamental research have priority for expanded attention. Examples of other potentially productive areas span the spectrum of biologic phenomena in plants and animals. This matter could be handled as a broad category of fundamental research into all aspects of cell biology and biologic behavior in plants and animals.

   b. We generally believe that the type of effort suggested is appropriate, given earlier comments that the range of fundamental biologic research identified might have been more comprehensive.

   c. The effects suggested, we believe, may be overly optimistic, particularly in the 10- to 25-year time frame. The substantial payoff to this kind of research is likely in the time frame of 20 to 50 years.

   d. Sources of support are clearly appropriate with the possible exception of the mention of EPA in the biological nitrogen fixation arena. We have some difficulty identifying more than a peripheral role for that Agency in fundamental biology.

3. Pest Management (p. 80)

a. Pests are a major contributor to shortfalls in food production, storage, and use. Research in this area is justified as high priority.

b. The effort suggested in preharvest losses is appropriate. Attention here and in storage is needed. Processing and preparation losses are addressed elsewhere.

c. We agree that application of current technology can avoid catastrophic losses in the short run. Longer gains require new biologic control technologies. A major limit is the availability and cost of present energy consumptive technology. Future methods must accommodate to less energy-intensive methods.

d. The Agencies mentioned are appropriate. Clearly, USDA with its State partners, should be the leader.

4. Weather and Climate (p. 83)

a. The area described is of high priority.

b. Effects are likely to be substantial, but "impossible to estimate." We agree with the estimate of substantial benefits. Much will depend on management changes the farmer/rancher makes as a result of having weather/climate information. Educational programs will be needed to help the manager identify alternate management decisions.

c. Effects predicted are realistic.

d. Appropriate sources are identified. "Lead source" in terms of leadership in budget requests to OMB and Congress should be identified, and other sources in order of priority also should be shown.

5. Management of Tropical Soils (p. 88)4/

a. This area is very high priority in view of the difficult nature of tropical soil management, our lack of knowledge in this area, and the fact that much of the future increase in food production must come from tropical soils.

4/ At the ARPAC meeting, it was suggested that agriforestry was omitted from the WFNS. In many tropical or subtropical areas, food and forestry products are produced together. In other areas food and forest production alternate to the benefit of both. These practices promise to increase both food and forest product production. The section on farm production systems indicates some practices that can be used. (p. 106) In many arid areas, forests protect watersheds, prevent erosion, and protect livestock, crops, and people from climate extremes. In most developing countries, forest products are an important source of fuel for household use.

b. The research effort described is most appropriate.

c. The effects projected are appropriate and achievable.

d. The sources of support are clearly appropriate.

6. Irrigation and Water Management (p. 90)

a. We agree that this is a priority area for research.

b. The nature of the research effort as summarized in the table on pages 60 to 63, has one deficiency, namely that of drainage and salt balance management. This is a most critical area that, if not given adequate attention, can quickly spell the doom of irrigation development. Although covered briefly in the text (p. 90), we were surprised to see this area left out of the summary statement on nature of research where it is most conspicuous by its absence.

c. The major effects noted are appropriate and achievable.

d. Sources of support are appropriate.

7. Fertilizer Sources (p. 92)

a. We believe this to be a priority area but might be better described as fertilizer technology rather than fertilizer sources. Use of the term "sources," we believe, gives the wrong connotation and is not consistent with the nature of research described.

b. We believe the nature of the research effort described is on target.

c. The major effects are achievable and well stated.

d. Sources of support are likewise appropriate.

8. Ruminant Livestock (p. 95)

a. We recognize that this is a priority area of concern but believe "small ruminant and nonruminant livestock" might be added.

b. The nature of the research efforts in our view, although recognized in the list, gives inadequate attention to forages and nonruminant livestock that are "scavengers" in the poorer countries.

(1). While recognized by the WFNS (p. 97), forages are important for reasons other than as a feed for ruminant livestock and deserve a separate listing. Forages include both grasses and legumes and are major world crops in terms of value and area. More land is devoted to their production than all other crops combined. In addition to providing more than half the feed units consumed by ruminants, forages provide needed ground cover to reduce soil erosion, and legumes fix atmospheric nitrogen for soil improvement,

give high forage yields without added nitrogen, and increase the yields of associated grasses. Improvement of forage yield and digestibility would do more to increase ruminant (beef, dairy, and sheep) animal production than animal improvement itself.

(2). Swine, poultry, rabbits, and guinea pigs are very important food animals in the developing countries. These animals can be raised under production systems that are not competitive with humans for energy or protein. The nonruminant animal is an omnivorous scavenger that can be produced very efficiently with otherwise wasted resources. These animals offer greatest potential for the poorest people in the poorest countries.

Clearly, the nature of research should include some reference to "means to upgrade wasted or underutilized materials," which would refer to swine and poultry as well as to ruminant animals.

c. The projected results are realistic given the deficiencies suggested under items a and b.

d. The agencies indicated are appropriate.

9. Aquatic Food Resources (p. 99)

a. We agree that there is sufficient potential in improving aquatic food sources to warrant this being a priority area.

b. The nature of research suggested is generally adequate. The most feasible approaches are through use of marginal lands not utilized for other farming and application of polyculture techniques and selective breeding.

c. We doubt that the research outlined can realistically double fish protein consumed by humans without increasing world catch, which is near maximum sustainable levels. We do believe that increasing aquaculture yields from 5 to 25 million metric tons is entirely feasible.

d. The sources of support suggested are appropriate. We do suggest the need for a stronger focal point of leadership for aquaculture research, whether it be fresh or brackish water culture. We suggest that the leader for this area be USDA as this Agency leads other food production and farming enterprises.

10. Farm Production Systems (p. 103)

a. Farm production systems represent a valid priority. The fight against hunger and malnutrition must be fought on all geographic fronts, and a basic force in that fight is an efficient and effective farm production system.

b. Improved production systems, methodologies for identifying the most efficient farming systems, multiple cropping, efficient soil and water management, and labor intensive activities can contribute to increased production and higher incomes, particularly for small farms in developing countries. A useful approach to identify appropriate farming systems might be to devise a standard classification scheme for soil, climatic, and other environmental characteristics in all countries. With such a classification it might be easier to hypothesize which systems are more appropriate for various countries. In utilizing an underemployed labor force, methods of multiple cropping and year-round production of agricultural commodities would improve the situation; however, some countries may need to develop cottage industries within the communities effectively and productively to utilize labor in off-season times. For example, if simple equipment can be designed to use in agricultural production, it might be efficient to develop small industries that produce the equipment right in the community and utilize farm labor in off-peak times to produce it.

c. We question whether a fourfold increase in production in the humid tropics is possible in the 10- to 15-year time frame. We agree that more potential exists in the humid tropics than in the arid and semiarid tropics, aside from opportunities to enhance irrigation.

d. We are in agreement as to sources of support suggested.

C. *Conclusions Concerning the International Framework:*

> ...A large part of the research needed, especially applied and adaptive research, will have to be carried out in developing countries... The capacity of the developing countries for research and its application must be substantially enlarged. (p. 128)

We clearly agree with the first conclusion stated, namely that a large part of the applied and adaptive research needed will have to be carried out in the developing countries. This suggests the need substantially to enlarge that capacity in the developing countries.

> ...a number of international research centers and programs have been established in tropical countries... with demonstrated capacities to accomplish research... Consequently, the work of international research centers and programs concerned with food and nutrition should be extended and strengthened. (p. 128)

If we properly interpret the second conclusion, we are in substantial agreement. The international research centers need to be strengthened, particularly those that are of recent origin and thus not as well developed as the earlier ones. The centers have a strong role to play and their strength needs to be maintained or enhanced, or both.

We are not entirely clear as to what is meant by the statement that the centers and programs should be "extended." If this means development of linkages with both developing and developed countries and the "extension" of the centers' efforts and the output from their programs, then we are in complete agreement. If the word "extended" is intended to mean that a number of new centers should be developed, then we have serious reservations. We would offer one area for consideration, however, that being the area of food processing and preservation, storage, and dispersal, tailored to these developing countries where very small farm operations are the rule. This presents some unique problems that are likely to receive inadequate attention in developed-country research and are unlikely to be solved in developing countries unless there is a strong focal point of activity applicable to this situation.

> A large part of the research needed, especially basic research but also applied and adaptive research, will have to be done in North America and Europe,... Consequently, the United States should enlarge and reshape its research on food and nutrition. (pp. 128-129)

We have some difficulty with the third major conclusion. We agree that the bulk of the more fundamental research as well as substantial elements of applied research will have to be done in the developed countries where large resources in science are available. Thus we have no difficulty with the notion that the U.S. research on food and nutrition needs to be substantially enlarged.

We have some difficulty with the reshaping notion, particularly as related to the idea of very large inputs into fundamental research through "new" mechanisms and institutional arrangements. We do not have such difficulty with the language relating to the need for more emphasis on research with international objectives, the need for expanded fundamental research, and the proposal for some new thrusts in human nutrition. In particular, we applaud the indicated support for social science research relevant to food and nutrition problems in the developing countries. In our introductory remarks, we addressed several of these points.

D. *Recommendations for U.S. Action:*

We are in complete agreement with many of the recommendations for U.S. action contained in the WFNS. We question others.

1. The Federal-State system of agricultural research:

> ...the appointment of an Assistant Secretary of Agriculture with responsibility only for research and education. (p. 134)

We fully concur in the recommendation for an Assistant Secretary of Agriculture with responsibility only for science and education.

> ...substantial increases in federal funding (1) for the traditional USDA research programs (including support for state programs), and

(2) to establish a program of competitive grants for research on food and nutrition. (p. 135)

We fully concur in the recommendation for substantial increases in Federal funding for traditional USDA-sponsored programs, including support for the State portion of that partnership. We likewise concur in the recommendation for enhanced competitive grants programs currently a part of the Food and Agriculture Act of 1977 and appropriation for USDA in the fiscal year 1978.

> ...a first year increase of $120 million...the new funds to be divided equally between existing federal-state channels and the new competitive grants. Thereafter...successive increases, ... approximately 10 percent per year in real terms, also divided evenly between existing programs and competitve grants. (p. 136)

We concur in the recommendation of a 20-percent increase for first-year expansion of USDA food and nutrition research. We doubt that the 10-percent yearly increase in real terms for the following 4 years is adequate. We believe that the targets suggested in Title XIV, Food and Agriculture Act of 1977 for food and nutrition research are likely more in keeping with the need.

Finally, we seriously question devoting half of the expanded resources to the new competitive grants program; if needed, it is a project-oriented competitive grants activity. We would support the notion of half of the resources going to competitive grants if half of that half were devoted to institutional development objectives to meet international food and nutrition problems.

Specifically, we could visualize allocation of $30 million the first year and substantially increased amounts in subsequent years to the development of specific research capability domestically that would contribute both to domestic and international needs. Such an institutional grants approach would entail continuing commitment on the part of the institution petitioning for such funds to retain that capacity to contribute so long as that capacity was a priority need.

We believe that the competitive project grants, $30 million the first year escalating perhaps to as much as $60 million after 5 years, is a more appropriate level than double that amount.

> ...a five-year federal matching grants program for non-federal research facilities and equipment. These grants should be available to other universities and private institutions as well as those in the land-grant group. (p. 138)

We concur in the recommendation for non-Federal research facilities and equipment. Clearly, a physical capability to perform more strongly is needed. However, we do question the matching requirement for facilities supportive of programs that are largely, if not completely, targeted at international food problems. We would agree with a matching requirement for facilities and equipment aimed at domestic problems but do not see this as viable for programs aimed at nondomestic problems.5/ Perhaps the wording for facilities and equipment in that category should be "cost-sharing" rather than "matching." We could see a variable cost-sharing approach based on the relative apportionment of benefits domestically and internationally.

2. The report makes five recommendations for AID: (p. 140)

> ...have a larger and more systematic effort...to help the developing countries establish research and development capabilities for food and nutrition in both the natural and social sciences. (p. 140)
>
> ...a larger and better-designed AID effort to train research personnel for the developing countries. (p. 141)
>
> ...the establishment of a joint AID-university committee on international training under Title XII of the Foreign Assistance Act. (p. 142)
>
> ...continuation of AID support for international research centers and programs... (p. 142)
>
> ...that AID enlarge significantly its support for establishing operating relationships between U.S. research groups and those in developing countries. (p. 143)

We believe that all of the recommendations for AID are appropriate. We agree that AID should substantially expand its technical capacity in food and nutrition research and education, either through direct employment or through contractual arrangements, possibly under Title XII of the Foreign Assistance Act, so that a greater technical capacity is available to guide the AID-funded programs in developing countries and elsewhere.

3. We concur in the recommendations with respect to the National Institutes of Health. 6/ (pp. 145-146)

4. We fully concur in the first three recommendations for the National Science Foundation. We have some questions concerning the other two.

> ...vigorous action by NSF under (fiscal year 1977 authorizing legislation) to promote international scientific collaboration. (p. 147)

5/ A letter from NAS indicates the matching requirement would be variable, depending on the extent of costs related to international objectives.

6/ Recommendations are summarized on p. 9.

We agree that NSF should take leadership under the 1977 mandate to promote international scientific collaboration. However, we believe that principal responsibility in the food and nutrition area with respect to both developed and developing countries should rest with the partnership of AID, USDA, and the universities. NSF's role would be related to the basic sciences which should concentrate more particularly in the developed countries at least for the foreseeable future. The capacity in developing countries is more clearly needed in problem solving in contrast to fundamental research.

> ...that a program of training in interdisciplinary research be undertaken because of its potential for dealing with food and nutrition problems. (p. 147)

We are favorably disposed to programs of training in interdisciplinary research, but we doubt that NSF is an appropriate focal point for needs of the developing countries. Further, we suggest that principal sponsorship of such efforts might rest better in the Office of Education of HEW, under the new mandates of USDA, or through the training activities sponsored by AID.

5. The WFNS recommended for Privately Supported Research: (p. 148)

> ...AID enlarge use of contracts to draw on...private companies to contribute to research and research training objectives in developing countries. (p. 149)
>
> ...that USDA...make greater use of private resources... for needed aspects of food and nutrition research... (p. 149)
>
> ...coordination and simplification of regulations affecting research and development on food and nutrition research be given early attention. (p. 149)
>
> ...early evaluation of U.S. and international proprietary rights. (p. 150)

We concur in the third and fourth recommendations. We likewise concur that there is capability in the private sector for effective delivery of research and development in aspects of the total problem that may not be appropriate to public agencies or universities. In such cases, both AID and USDA should tap those resources.

However, the proposal that AID and USDA substantially enlarge efforts along this line may be misleading. Both agencies now utilize those resources effectively and significantly as appropriate to their missions.

6. The following was recommended for the Executive Office of the President:

> ...the establishment of two entities...; one to develop and maintain a coherent U.S. strategy for dealing with world food and nutrition problems; the other, ...to facilitate coordination of U.S. and international research activities on food and nutrition. (p. 151)

Section 1406 of the Food and Agriculture Act of 1977 established the Subcommittee on Food and Renewable Resources of the Federal Coordinating Council for Science Engineering and Technology (Office of Science and Technology). This legislation became law after the WFNS was issued and provides a mechanism to deal with the two elements of the recommendation.

E. *Recommendations for ARPAC Action:*

1. ARPAC should review and react to the report of the Strategy Group. Given agreement on the reactions, these should be made known to appropriate elements of the Federal establishment and the university community through the Secretary and the National Association of State Universities and Land Grant Colleges.

2. ARPAC should proceed aggressively to address areas of priority research through the national and regional planning system and should bring to fruition a 5-year projection on resource needs.

3. ARPAC should react to the Food and Agriculture Act of 1977 and its implications with respect to the USDA-university partnership and assure that recognition is given to the international dimension of the food and nutrition problem, given the increased visibility and new mechanisms provided in Title XIV and under Title XII of the Foreign Assistance Act of 1975.

IV. FOOD MARKETING

The following comments are a synthesis of the suggestions and reactions of a special subcommittee of the ARPAC Research Strategy Group dealing with the area of food marketing as covered in the World Food and Nutrition Study.

The subcommittee was impressed with effort embodied in this report and substantially agrees with its thrust. This is an important document, deserving of wide attention and discussion. Implementation of its recommendations would contribute measurably to improving the world food and nutrition situation.

An overall reaction to the report with respect to food marketing was that much more attention was given to "before the farm gate" problems than "after the farm gate" problems. Only a minimum of detail and presentation was centered on food marketing, compared to the other three major categories. This seems inappropriate in view of the range and scope of postharvest problems and the potential for immediate and significant returns. We understand that WFNS leaders invited priority inputs from several sources in this area, but these responses did not provide additional priority suggestions.

Specific comments by the committee are organized as responses to the charge given the subcommittees by the Research Strategy Group.

A. *The 22 priority areas cited in the WFNS.*

Our subcommittee felt that the study is reasonably cohesive; we do suggest the following additions within the general parameters established in chapter 1:

The study lists only two priorities in the food marketing area, namely postharvest losses and market expansion. Though these terms are sufficiently broad to encompass the major aspects of the food marketing category, it would seem that certain segments are sufficiently important to merit the same emphasis provided in the food production category. We feel, therefore, that these two priorities should be expanded to the following: (1) Bioregulation and Postharvest Physiology: Identify biochemical tools for postharvest control of sensory and nutritional quality and pest resistance, (2) Postharvest Pest Management and Host Resistance: Reduce postharvest losses due to pests; identify commodities with inherent pest resistance, (3) Preservation, Processing, and Physical Protection: Devise processes, products, facilities and packaging appropriate to technological capabilities and climatic demands, (4) Transportation and Distribution: Improve transportation and distribution systems in modes consistent with cultural, technological, and geographical requirements, (5) Systems for Food Marketing: Optimize food delivery systems from farm to consumer to minimize losses and cost and develop methodologies for identifying appropriate systems.

B. *Nature of suggested research described in chapter 2 and summarized in table 3.*

If the number of priorities cannot be expanded, we suggest the following additions to category III of table 3 in the section "Nature of research effort":

1. Under the subheading "Postharvest losses," add the terms bioregulation, postharvest physiology, and host resistance (new tools for reduction in food losses).

2. Under the subheading "Marketing Expansion," add "technological assessment (analyses of changes in technological base as they affect the marketing systems)."

We refer in the above to the interface between culture and environment on the one hand and technology on the other. There is need for anthropological, sociological, and psychological analysis of the recipients and their assimilation of different forms of new technology. The constraints to adoption or acceptance of new technology need identification. Our understanding of the impact of technology on society and its institution and vice versa is limited. Adapting technology to meet social and marketing criteria should be evaluated more seriously.

C. *Effects of planned research.*

The report is to be commended for trying to consider the effects of research. The discussion of major effects as presented is quite thin. We feel that there can be a higher payoff from marketing research in developing countries than is suggested by the report, and perhaps also than has existed in the United States. The United States and other developed countries have built a marketing structure over time through the public and private sector, while in the developing countries important parts of the infrastructure for a marketing system have not materialized. Marketing has been shortchanged in the report. Opportunities for contribution from marketing work are greater than indicated. The potential role of improving human welfare has not been emphasized appropriately, although we understand that efforts to become more specific in the WFNS were not successful.

D. *Sources of support.*

The appropriate sources of support have been identified. A lead source cannot be identified logically in each case. We question whether the sources should be listed in order of potential for contribution or in order of priority. We suggest that for category III, Food Marketing, the Commodities Futures Trading Commission might be added as a specific source of support. For category IV, Trade Policy, the U.S. Treasury Department should be added as a key Agency.

E. *International Framework.* 7/

The section on international framework (pp. 128-133) is quite acceptable. On the top of page 129 the comment that "present resources for research on food and nutrition in the United States are in important respects inefficiently used" needs explanation or substantiation.

We agree with the conclusions indicated in this section. Marketing research of the type visualized, particularly that conducted by economists or other social scientists, has to be done largely in developing countries.

7/ Refer to pp. 128 and 129 for WFNS conclusions.

F. *Recommendations for U.S. action.*

1. The Federal-State System of Agricultural Research

> ...the appointment of an Assistant Secretary of Agriculture with responsibility only for research and education. (p. 134)
>
> ...substantial increases in federal funding (1) for the traditional USDA research programs (including support for state programs), and (2) to establish a program of competitive grants for research on food and nutrition. (p. 135)

We support the concept of consolidating research activities under an Assistant Secretary in the USDA. These research activities should include other research Agencies in the USDA such as the research arm of the Forest Service. The policy role mentioned for the Economics, Statistics, and Cooperatives Service is crucial (p. 135).

> ... a first year increase on the order of $120 million, something under 20 percent of the total of about $700 million of USDA and state funds now devoted to food and nutrition research. We propose that the new funds be divided equally between the existing federal-state channels and the new competitive grants program. Thereafter, we recommend successive increases, after adjustments for inflation, on the order of $60 million or approximately 10 percent per year in real terms for the next four years, also divided evenly between the existing programs and the new competitve grants program. (p. 136)

The funding under PL 89-106 has been too small in the past. There is ample justification to increase both formula funding and competitive grants for food and nutrition research. In the competitive grants area, peer review is necessary; it should be separated from priority setting. We favor a strong competitive grants program with the program centered in the Assistant Secretary's office.

The food marketing subcommittee has a concern about communication and coordination of the competitive grants program with existing research Agencies in the USDA. The competitive grants program needs the financial base indicated in this recommendation to be effective. There is no point in creating the machinery without the funding. In this section overhead is not recognized as a cost or as a contributor to university development.

We concur with the idea of a broadened mission for the U.S. agricultural research establishment.

2. Agency for International Development (AID)

Among the recommendations for AID was the following:

> ... a larger and better-designed AID effort to train research personnel for the developing countries. (p. 140)

We question designing specialized graduate programs for foreign students. Some thoughts concerning ways of improving the handling of foreign students include (a) better guidance for foreign students as they initiate their programs, and (b) assistance in the development of graduate centers in the developing countries for the training of their students, at least through the Master of Science level, although some specialized courses might help them deal with problems in their nation.

3. National Science Foundation (NSF)

Among the recommendations for NSF was the following:

> ...that a program of training in interdisciplinary research be undertaken because of its potential for dealing with food and nutrition problems. (p. 147)

We question this recommendation. We support the concept and reality of interdisciplinary research but do not think that an effective program of interdisciplinary training can be established. One learns interdisciplinary research by doing and by creating an environment where such work is natural and possible. One of the steps in interdisciplinary work is to expose people in one discipline to the processes of another. We suggest more training in the philosophy of science and the use of postdoctoral experience at research centers where such work is now in process.

Our subcommittee commented on the need for evaluation of institutions and mechanisms for transferring information about technology and knowledge in developing countries. Are training programs in agriculture appropriate? Are the assumptions about such training programs correct, such as the need for literacy on the part of the recipients? We need greater knowledge about the transfer process and the requirements of the recipients of such technology.

We think that the innovations suggested for the Executive Offices of the President are necessary and appropriate.

G. *Recommendations to ARPAC.*

In summary, the food marketing subcommittee felt that the WFNS is valid and useful. We recognize that there are different ways of looking at the study but generally agree with its content and consider it to be an important document. We did feel that marketing was not given a fair share of attention in the WFNS, but we recommend that ARPAC support this study and recommend its implementation.

V. POLICIES AND ORGANIZATIONS 8/

In approaching deliberation of its charge, this subcommittee considered both issues relating to "research on policy and organization," especially those areas of studies discussed in the WFNS beginning on page 114, and issues relating to "policy and organization of research" in a more general context. In general, the subcommittee concentrated on its assigned area. Where considerations relating to the policy and organization of research required a broader perspective of the issues, all areas contained in the WFNS were examined. The subcommittee initially responded specifically to the first six questions contained in the strategy group's charge memorandum; however, the subcommittee also addressed the issue of research policies and organizations in more general terms in response to the seventh question in that memorandum.

The subcommittee's report is presented in three parts:

(1) In general terms, an appraisal of the applicability of the overall WFNS model as a base for determining strategy relevant within the United States.

(2) Evaluations of specific areas requested in the charge memorandum, namely: Priorities, research topics, organization, and recommended actions by WFNS.

(3) A discussion of issues raised by the WFNS that the subcommittee considers relevant for further action.

A. *The WFNS Model.*

Out of the extensive analysis and deliberation of the world food and nutrition system and problems and the associated evaluation and determination of research and related needs, the rudimentary features of a model of the world food and agricultural sector have emerged. Partly explicitly but mostly implicitly, this model was created and used by the WFNS Steering Committee and staff in arriving at the recommendations related to policies and organizations contained in the WFNS. The particular characteristics of this model originate partly from the task assigned to NAS by the President, partly from observations and assessments made by the WFNS staff and study groups, and partly from the discipline-related perspectives of the WFNS staff who conducted the analysis. No judgment is made in the following regarding the correctness of this model; however, its particular features and implications deserve consideration in evaluating the appropriateness of conclusions that might be drawn from using that model in determining domestic U.S. food and nutrition policy and research strategy.

8/ The subcommittee wishes to thank Walter L. Fishel, SEA, for preparing the initial report and Marlene Evans, SEA, for typing the several drafts.

1. General Description of the WFNS Model

a. A World Model: By explicit intention, this study pertains to agricultural, food and nutrition, and related socioeconomic elements of the entire world. All societies are considered part of an integral whole.

While it recognizes that there are differences in societies, economies, and food and nutrition patterns, such differences are not taken as a given from which the model dynamics progress. In essence, it implies a "standard" of nutritional needs of all people and does not build into the model the basic differences in consuming patterns and the probable dynamic impact these might have on model structure or performance.

b. A Suboptimization Model: The intended product of the model is to optimize the impact on human nutrition through carefully orchestrated research and affiliated activities. This includes research performed in all countries to the extent it is possible to do so but mainly through research and educational activities and related policy originating in the United States.

It is recognized that optimum human nutritional status is brought about only through the interdependent operation of a large number of political, economic, and institutional factors. Solutions will be found only through a composite of actions in the areas of production, population, and consumption (income plus expenditure patterns). The role of research is to improve the options available in these multifaceted areas for resolving the total nutrition problem.

We in the United States can alter our own institutional arrangements and decisions as they impact on research and education. We can probably influence significantly some foreign research and research-related institutional decisions, including developing countries. We are likely to have no control over the particular design of nonresearch social, political, economic, and institutional arrangements in foreign countries, however much these may impact on the success of technology transfer related to improving human nutrition.

The WFNS suboptimization model emphasizes the critical role and importance of factors other than research in achieving the desired state but does not indicate the processes for removing these as impediments to the efficient transfer of research-produced technology. It does, however, call for research on this matter.

c. The Optimization Function: The basic function to be optimized is the impact on human nutrition throughout the world--basically, how to proceed so that research in the United States and in developing countries can produce the maximum impact on nutrition throughout the world. This assumes that the target of model dynamics is to raise the quantity and quality of food consumed by humans to a level above what it is now.

Implicitly, this indicates basically a longrun model. It sets forth a desirable state to be achieved, as well as the conditions that evidence indicates will bring about this state, but it provides no indications of the nature of intermediate states. Since it is presumed to be obvious to the

steering committee that the "ideal" states cannot be achieved in one quantum jump, the model must depict a system that can evolve to this ideal state.

Principal assumptions about the current state of the food production environment that impact on the selection of research functions to be included in potential strategies are: (1) higher energy costs, (2) diminishing returns to capital, (3) leveling of crop and animal yields, and (4) environmental contaminations. This leads to the inclusion of functional relationships for research in both developing and developed countries that result in less reliance on capital intensive technologies toward technologies that represent fundamental changes in biological factors of food production. These, too, represent elements of a longrun model.

d. Organization of Research: The organization of research in the WFNS model is treated basically as if there were a single world research system in much the same sense as the Federal-State-industry system is considered one system in this country.

There is a basic goal of effective integration of the three major components of this worldwide system--the national research organizations, the international systems, and research organizations in the developed countries (principally United States)--that collectively provide the research and educational functioning required to produce the desired impact on human nutrition throughout the world. The integrative forces for this worldwide research system are certain selected organizations, serving essentially as clearinghouses for technical resources and agents for information, planning, and coordinating. The rice research network is presented as one model. (Appendix C)

Distribution of research is based on a division of labor in which each component contributes the part of the whole research task that it can do best. Such distribution of labor is to occur largely without central direction; it occurs through normal interaction among researchers and planners. The principal mechanism for guiding this distribution of research effort is through funding grants, as it is in the public sector in this country. This is largely in lieu of a marketplace for the products of research.

e. The "Political Will": A substantial assumption behind the WFNS model is that a commonality exists of public perspective and interest in both the United States and developing countries to permit the development of policies by affected governments to provide further efforts toward a worldwide food and nutrition research system. This factor is not included within the model itself but is considered an environmental factor impacting on the operation of the model proper.

2. WFNS Model Relevance to ARPAC Research Strategy

The conclusions and recommendations of the WFNS describe many desirable actions that would benefit world human populations. While it would be difficult to find fault with most of these findings for the United States, developing strategies for implementing them in a domestic research program based on the premises of the WFNS model presents conflicts that may not be easy to resolve. A discussion of some of these conflicts follows:

The concept of a world model internalizes many factors that are external concerns to a domestic model. These include issues such as foreign trade, funding and international exchange, policy control, and others addressed in the following paragraphs.

Several questions arise in determining an optimum research strategy for the world model when domestic programs can exert negligible control over policies, social factors, or institutional arrangements in foreign countries that can severely limit the application of technologies produced by research, whether in this country or in target countries, namely:

1. Should these factors be included as limitational functions in the WFNS model in determining research strategies?

2. Would research strategies change if such limitations were included or if they were to change in time?

3. Would short-term strategies be different from long-term strategies if such limiting factors are included, especially for domestic involvement in the worldwide system?

4. To what extent dare we commit necessary resources to implement a domestic research strategy that contributes to the strategy set forth in the WFNS model on the assumption that the institutional barriers can be removed in time for technology produced to have its intended effect?

The worldwide nutritional standards implicit in the optimizing function will need to withstand some political realities of policymaking in this country. The United States far exceeds these implicit standards. Our "political will" expects even better from our research. Research strategies designed to raise human nutrition up to the worldwide standards are not the same as those to raise nutrition beyond where we are in this country now. A basic conflict may exist in the kinds of research included in the two strategies.

Some variation exists among the four environmental factors in how influential these are to shaping the basic research strategy under the WFNS model. For example, diminishing returns to capital in and of itself may be a relevant concern only if the aggregate production is a major goal of a foreign country. Also, environmental constraints are of varying importance throughout the world. These all have different implications to the mix of a research strategy in this country and others in setting research strategies.

The organizational premises of the WFNS model may be extremely difficult to handle within the context of a domestic research strategy, again for reasons of responding effectively to our body politic. There is a notable need for mechanisms to assure a clear-cut commitment from foreign organizations who would be expected to perform some of their research. An integrative force in the worldwide system is needed that would almost take the form of an international agricultural and food plan having treaty stature. To date, we have not been able to devise such a plan within the United States. When it is developed, it will reflect domestic rather than international interests.

The division of labor concept has worked reasonably well in the agricultural research system because it has been backed up by a complex rewards system. This concept also could work in the worldwide system, but the rewards system would be extremely complex and difficult to establish. In addition, the international rewards systems would undoubtedly interfere with the domestic rewards system and confuse signals controlling domestic research programs.

The "political will" concept is undoubtedly the most questionable attribute to the WFNS model. It does not exist presently. A favorable "political will" must be considered an absolute in the United States. Strategies for implementing a worldwide system can be implemented only to the degree that the "political will" wishes it to be implemented. Consequently, the present status of the "political will" and how it can be nurtured is of prime importance in determining a strategy for U.S. research in food and nutrition.

B. *Are the 22 priority areas appropriate?*

The priority areas indicated by the WFNS are:

Nutrition-Performance Relations
Policies Affecting Nutrition
Plant Breeding and Genetic Manipulation
Resistance to Environmental Stresses
Pest Management
Management of Tropical Soils
Fertilizer Sources
Aquatic Food Sources
Postharvest Losses
National Food Policies and Organizations
Food Reserves
Role of Dietary Components
Nutrition Intervention Programs
Biological Nitrogen Fixation
Photosynthesis
Weather and Climate
Irrigation and Water Management
Ruminant Livestock
Farm Production Systems
Market Expansion
Trade Policy
Information Systems

Prior to the release of the WFNS, ARPAC requested that recent reports suggesting priority agricultural research be surveyed. This survey was conducted by Drs. James Turnbull and E. L. Corley. Their report was accepted by ARPAC and is scheduled for publication. Upon release of the WFNS, a comparison of it to the other surveyed studies was made by E. L. Corley. An important distinction is that the WFNS focused substantially on the international and the studies reviewed by Corley and Turnbull on the U.S. domestic problems. While this distinction made point-by-point comparisons between the two sources difficult, there were no fundamental conflicts in recommendations and there were many points of agreement.

Both sources agree on the need for a clearer food and nutrition policy; the need for considerable strengthening of funding for food and agricultural research; and the need for improved R&D facilities in the United States. The reports surveyed by Corley and Turnbull specifically identified all of the 22 priority areas listed above except (1) policies affecting nutrition, (2) nutrition intervention programs, (3) trade policy, (4) food reserves, and (5) information systems.

All things considered, the thrust and content in the WFNS present little that is particularly new or different from past food and nutrition studies, except specific recommendations as to level of funding among identified R&D organizations, organizational steps, and the degree and nature of integration of the U.S. and international research systems. Therefore, the committee accepts the 22 priority areas listed above as being a satisfactory listing of relevant research priorities in the food and nutrition research area.

C. *Will suggested research achieve hoped for results?*

The WFNS suggested the following research for the indicated priority areas:

National food policies and organizations	Improve policies and organizations affecting food production, distribution, and nutrition in developing countries: Human performance in food systems; comparative studies to identify transferable improvement factors (decentralization, local participation, staff development); interactions of income distribution with food production and nutrition; methodology of sector analysis.
Trade policy	Improve effects of trade policy on food production and nutrition: Studies on effects of trade liberalization; consequences of international management of trade; optimum trading patterns.
Food reserves	Improve role of reserves in relation to other measures for stabilizing food supplies: Improving developing country food reserve practices; identifying improved mixes of reserves; and other measures to stabilize food supply.
Information systems	Improve flows of information in support of decisionmaking on food and nutrition: Producer information needs to use better technology; crop monitoring systems; international data bases on land uses and malnutrition; information systems design.

The subcommittee has the following observations:

1. Response requires a degree of expertise and time not available to the subcommittee to fully assess.

2. Research effort appeared appropriate to the problems. The subcommittee offers no new approach.

3. WFNS may be optimistic in implying a greater role for U.S. scientist in the developing countries than is currently feasible. Most problems

are country specific and must be researched in the developing countries. A training and support role, through centers, may be the primary route in contrast to U.S. nationals working in developing countries. High cost, tax policy, and political acceptance are problems of fuller U.S. personnel participation.

D. *Are major effects of planned research realistic?*

Estimated major effects of suggested research listed above are given by the WFNS as:

National food policies and organizations	Early results in improving effectiveness of policies and organizations relating to food systems and orienting selection and implementation of other biological and physical research; give farmers incentives for production and provide prices that will give more effective distribution.
Trade policy	Early effects on orienting country food policies for balance between own production and reliance on trade; improve diets, incomes, and national economic performance.
Food reserves	Relieve hunger and malnutrition resulting from production instability.
Information systems	Large gains, especially in developing countries, from fewer wrong decisions and fuller use of available improved technologies.

The subcommittee's reactions are:

1. Projected results were qualitative. The subcommittee agrees that successful research efforts would lead toward the predicted outcomes.

2. Research is not going to solve all the important problems regarding trade, food reserve, and national food and nutrition policies in developing countries. The United States and many other developed countries have policies that are inconsistent with existing research results or have failed to develop a codified policy. This suggests that research on the process of formulating policy may have highest priority.

E. *Are appropriate sources of support indicated?*

The sources of support indicated by the WFNS by priority area are:

National food policies and organizations	AID, NSF, USDA
Trade Policy	USDA, AID, State, Commerce
Food Reserves	USDA, AID

Information Systems USDA, NASA, DOD, NOAA, AID

The subcommittee has the following comments:

1. Both policies and information systems need to be considered separately for the developing countries and the United States and are so considered in the following:

a. U.S. Policy: In the United States, food and nutrition policy needs to be considered jointly with trade policy and food reserve policy. The interactions make it difficult for any department to take the lead. Most research will be in the USDA-Land Grant system, but the Departments of State, Commerce, Defense, Treasury, Energy, and possibly Transportation have involvement in what should be researched. (Appendix D)

The subcommittee agrees that all the relevant parties to policy must be involved in planning and interpreting research relating to policy. They need to be involved in planning research to assure that the research covers all variables of relevance to those that are to be influenced by the policy. Involvement in interpreting research will improve acceptance of the validity of conclusions based upon the research. Such involvement is far from assuring certain success but may marginally improve the present situation.

There are many aspects of policy and organization both in the United States and in the developing countries where basic knowledge is deficient. For example, guiding principles are needed that suggest appropriate organizational structures for particular cultural settings. NSF has the opportunity for an important contribution in this area.

b. Policy of Other Nations: Institutional involvement in developing countries comparable to that outlined for United States may be needed. AID should be the appropriate route (including use of Title XII of the International Development and Food Assistance Act of 1975). The USDA-Land Grant system should support AID efforts with personnel and other resources difficult to obtain in developing countries.

c. Information Systems: The primary need related to information systems in developing countries is for assistance in applying existing techniques and relating to established or developing systems. AID is appropriate for this function. Scientific resources should be available for this effort through Title XII.

The United States has a national need for an improved world food and nutrition information system. Although this need is not closely related to the needs of the developing countries, data collection in the developing countries would be essential. The USDA-Land Grant system is the appropriate sponsor for such research. However, NSF should be involved in the more basic questions relating to statistical design and to information theory.

An important part of the information system is that of a comprehensive world bibliographic inventory, comparable to the U.S. national system AGRICOLA. Progress in this direction has been substantial. FAO has sponsored the operation of such an inventory. Unfortunately, the indexing structure of

the FAO system, AGRIS, differs from that used in AGRICOLA. It is not politically feasible, if technically possible, for the FAO system to be converted to the AGRICOLA system. A long-range objective should be the conversion of AGRICOLA to the AGRIS system. However, there are important shortrun problems, such as the dependence of the "Bibliography of Agriculture" upon AGRICOLA and the fact that AGRIS now contains only about half the U.S. citations that appear in AGRICOLA. This latter problem is one of resource limitations. The Science and Education Administration (SEA) does not have the resources (personnel) to index the remaining material for input into AGRIS. The materials obtained by AGRIS from AGRICOLA are indexed in the AGRIS format by computer conversion. The excluded items need manual attention to convert.

With a relatively small investment ($100,000 or so per year) the entire AGRICOLA collection could be fed to AGRIS. The AGRIS system then would contain all the information that is in AGRICOLA plus some additional national materials. When the AGRIS system is thus completed, much of the work now done by SEA to get foreign publications into AGRICOLA could be discontinued. The resources freed may equal or exceed those necessary to index the U.S. input.

Changes in the U.S. system should not be made so rapidly that those dependent upon AGRICOLA input would not have time to make necessary adjustments. The quality of inputs from some nationals into AGRIS is less than fully adequate, but this is susceptible to improvement under guidance from Food and Agriculture Organization (FAO). The gradual merging of the base may take 10 years or more, but it appears to be an objective well worth pursuing.

A part of the U.S. national need, as well as the world need, is being served by research underway in cooperation between the USDA-Land Grant system, DOD, NASA, and others. This is the research related to remote sensing primarily from orbiting satellites. This work appears to be progressing satisfactorily under present sponsor relationships and must be related to the work of information systems discussed above.

2. With respect to leadership in research, the designation of a lead group or organization to get integration of research has not worked well. The group designated to lead is not given the power to influence the activities of the other parties that may be essential to the research. Each group naturally will put its best efforts into those areas in which it has leadership responsibilities, giving less intense attention to those parts of a problem for which another group had leadership.

This situation suggests that overall leadership reside at a level of administrative authority that will be able to influence the effort of all necessary groups. The WFNS therefore suggested a coordinating group under the Executive Office of the President.

However, this suggested solution also has its problems. The group formed at that level may be insensitive to the interests and capabilities of the subordinate groups. The Executive Office group may fail to gain or hold influence within the Executive Office. It is also difficult for such a supervisory group, formed to facilitate one line of work, always to be aware of the other lines of work that command attention in the subordinate units.

The subcommittee suggests that an organizational structure be sought that will have the capacity to federate the interests of all cooperating groups without creating a leader-follower relationship between members or administrative dominance over a fractional part of each member's activities.

The Food and Agriculture Act of 1977 authorizes and directs the creation of a cross-department committee to deal with food research concerns (Title XIV, sec. 1406). This committee, or a working subcommittee, should be tested as a means of achieving desired coordination. The Land Grant component of the system is not represented directly on the membership of this committee as designated by the act but probably could have representation on its subcommittees and participate in an advisory role on matters that touch its interest.

F. *Assessment of WFNS Conclusions on the International Framework.*

The WFNS states three conclusions with regard to the international framework. These are discussed separately below.

1. The first conclusion, which the subcommittee accepts, was:

> ...a large part of the research needed, especially applied and adaptive research, will have to be carried out in the developing countries, where the most serious shortages of resources for research on food and nutrition exist. Consequently, the capacity of the developing countries for research and its application must be substantially enlarged. (p. 128)

The study becomes more specific in making the following corollary recommendation:

> The United States should do more--and do it better--to train researchers for the developing countries, both through training individuals at U.S. universities and through helping build training institutions abroad. (pp. 130-131)

The subcommittee supports this view and suggests that much of the activity authorized under Title XII contributes to these ends.

Another specific recommendation of the WFNS was:

> The United States should do more to aid developing countries in the establishment of research facilities and institutions and in the application of research results. (p. 131)

We concur that this recommendation is an appropriate AID function. However, we observe that the problem of "doing more" relates only partly to AID authority and funding and willingness of the USDA-Land Grant System to

cooperate with AID. A part of the problem is knowing what institutions to build. Attempting to build copies of U.S. institutions has been demonstrated to be inappropriate in many settings and possibly less effective than some alternatives more in line with custom and culture of the developing countries. The implementation of action in this area should be preceded with studies of target countries' needs.

Another important part of the process of institution building must be the commitment of the developing countries to the effort. Such activities have some income and wealth transfer aspects that usually will make them acceptable to developing countries in the absence of any real intention of maintaining the effort after the external subsidy is withdrawn. If this occurs, valuable resources and time have been wasted and negative attitudes may have been generated. Again, the subcommittee urges that appropriate analysis be made prior to the launching of each particular effort.

The WFNS had a third specific recommendation in this area.

> The United States should do more to encourage and support communication and collaboration among researchers in the developing countries, in international and regional institutions, and in the United States, on problems of common interest. (p. 131)

The subcommittee agrees that this would be desirable even if considered solely in the U.S. self-interest. There is much to be gained by U.S. scientists at present. The WFNS mentions the contribution to U.S. agriculture from activities of the International Maize and Wheat Improvement Center in Mexico. Research of interest in the area of atmospheric nitrogen utilization by nonlegumes is going forward in Brazil. In addition, the U.S. involvement with other developed countries has been minimal to date. Beyond serving the U.S. interest, there would be a substantial contribution to the solution of world food problems as well.

The reasons for lack of commitment to international collaboration are not difficult to identify. Until the Food and Agriculture Act of 1977, the USDA had a very limited mandate to engage in foreign collaboration. The major important exceptions were in those instances of clearly demonstrated U.S. interest. How the act of 1977 provisions, which allow for the expansion of cooperation, will be interpreted administratively and supported in the Congress remains to be seen. In any event, the long-standing restriction on use of Hatch funds in foreign collaboration is not changed by the Food and Agriculture Act of 1977.

The subcommittee recommends that some organized effort be undertaken to develop a body of information relating to the advantages of this kind of cooperation. Only isolated examples are currently available. This evidence may not be adequate in the view of congressional leadership pressed by their constituents for support of research on problems of immediate interest.

2. The second conclusion was:

> ...the work of international research centers and programs concerned with food and nutrition should be extended and strengthened. (p. 128)

The subcommittee supports this conclusion but makes the following qualifying observations. First, it is becoming increasingly difficult for the U.S. research establishment to support the centers with personnel. The U.S. scientist has been "priced out of the market" to a large degree because of recent changes in income tax law. The previous incentives for U.S. scientists to serve in these centers are no longer sufficient because of the change in tax policy. The required incentives are so large that other nationals become the only practical alternative to the centers' management. The subcommittee recommends that attention be given to this problem because the situation may threaten to halt mutually beneficial interactions that have existed with the centers in the past.

Second, the longrun role of centers should be given careful attention. Their existence in large part results from the inadequacy of national research systems. This inadequacy is not likely to be soon removed. However, the degree of permanence in the centers should be determined by an estimate of time required to establish adequate national systems. Possibly a change in role over time away from applied research, which would be better done in a strong national research system, to one of training and information exchange is indicated.

The WFNS made three specific recommendations related to the centers:

> A new and broader approach is needed for research on nutrition. More epidemiologic studies are needed on the interrelations of nutrition and human development, nutrition and disease, nutrition and productivity. Nutrition research should be more closely related to the rest of the food system and its institutional components, from production through marketing to consumption.
>
> The U.S. research community should give much greater attention to international objectives. Much of the research done in the United States, particularly toward the fundamental end of the research spectrum, can serve users both in the United States and in the developing countries, if priorities are set and results communicated with overseas users in mind. Some U.S. research will need to be directed specifically to the problems of the developing countries; such research will require special arrangements for international training and support for U.S. researchers. In our view, these changes will not only permit the United States to obtain greater benefits from international scientific collaboration.
>
> Support for social science research relevant to food and nutrition problems should be increased sharply. We were impressed in the course of our study by the inadequacy of the policy analysis being used in the United States as well as in other countries to address questions about food and nutrition,

> and the correspondingly urgent need for the underlying social science research needed to support better analysis. In addition, social science research is needed to help determine priorities for production research, to measure the effects of technological change, to improve the functioning of markets and other institutional arrangements serving rural development, and for many other purposes (p. 133).

The subcommittee supports this recommendation with some qualifications, in part related to legislation passed since the WFNS was released, primarily the Food and Agriculture Act of 1977, and related in part realities of the current budgetary environment.

There is no doubt that more basic research is needed. It is just as true that more applied research is needed. Even so, from a longrun academic point of view the optimum allocation of resources probably favors more basic research relative to applied research. However, it must be recognized that decisions that have led to the present allocation were not made in the long-range academic frame of reference. Times have been very hard for most members of the USDA-Land Grant system for a considerable part of a generation. To survive, the system has had to adjust to a way of life in which the solution to relatively immediate problems is sought. In this context there can be no thought of apology for the current situation.

The subcommittee has reservations concerning the statement that resources have been "in important respects inefficiently used." Undeniably there are efficiency problems in these research establishments as in most, if not all, complex organizations. However, the social value of the total output is a substantial multiple of the value of the input, and in this sense the system is highly efficient. The center of this charge is that resources have not been targeted at what the WFNS considers to be the most urgent problems. There is truth in this charge, but the charge is not particularly relevant since the priorities urged by WFNS were not those given emphasis in the recent past. Indeed, there are yet no clear indications, reflected in budgetary support, that the agricultural research system should shift emphasis to these new priorities. When such clear indications are given, the subcommittee has confidence the system can and will respond with reasonable speed and efficiency as it has responded to problems in the past.

The WFNS assumes that constraints of the past are to be removed and recommends budgetary support for both more applied and basic research. The subcommittee believes a dual strategy may be appropriate until firmer evidence is produced than is now at hand to indicate basic changes are occurring in the basic budgetary environment. To plan a program on the assumption that the restraints of the last decade are removed could be disastrous if, in fact, those restraints prevail. To plan a program of greater emphasis on "basic" when the support is for "applied" is not a wise choice either for the research establishments involved or for the hungry of the world.

The call for "mobilization of scientific resources not previously involved" is quite appropriate in the subcommittee's view provided the scientific resources previously involved are first fully mobilized. The scientists within the USDA-Land Grant system have not had an opportunity in

recent years adequately to demonstrate their capacity, being restricted by lack of support facilities and personnel and bound to the applied tasks for reasons previously outlined. The subcommittee believes these resources should be the first utilized from an efficiency standpoint.

"Mobilization" of additional resources probably will come through grant funding. The subcommittee recommends that attention be given to the possible situation that could arise if increases are obtained by grants programs and budgetary pressure develops in the future. The political power of those supported by the grants program may be such that budgetary accommodation will need to be made in the institutionally supported program regardless of the merits of the two lines of work.

The conclusion regarding nutrition is supported by the subcommittee. It is appropriate to point out that the Food and Agriculture Act of 1977 has addressed some of the nutritional problems.

As noted earlier, the Food and Agriculture Act of 1977 offers some promise of progress in meeting the proposal that greater attention be given to international objectives. The subcommittee endorses the conclusion of the WFNS on this point.

The subcommittee gives unqualified endorsement to the recommendation relating to the need for greater social science input into both the domestic and foreign fields. The use of social science research in support of planning other research and in developing of organizations and formulation of policies to make such research more effective is emphasized by the subcommittee.

G. *Evaluation of WFNS Recommendations for U.S. Action.*

1. The Federal-State system of agricultural research: The WFNS made four general recommendations. Each of these is discussed in turn. With respect to the Office of the Secretary of Agriculture, the study notes

> We recommend the appointment of an Assistant Secretary of Agriculture with responsibility only for research and education (p. 134).

This recommendation originates because the present organization has no exclusive spokesman for research and education. The proposed Assistant Secretary would have supervision over SEA and ESCS. Related to this recommendation is a suggestion that ESCS be relieved of its day-to-day service role on policy matters to the Secretary and that only a research staff remain in ESCS. The study also recommended specifically that ESCS be strengthened and have social sciences other than economics represented on its staff.

The subcommittee had the following comments regarding this set of recommendations. First, the Food and Agriculture Act of 1977 attempts to establish a forum for research and education in the authorized "Board" and "Council" and their supporting staff. The subcommittee holds that this structure should be tested before additional administrative changes are made.

Second, the subcommittee believes the intent of the proposed changes in ESCS has some merit but that the proposed remedy is not in the best interest of either sound policy advice or good economic research. The Secretary can obtain advice from the best of his employees whether on his staff or in Agencies of the Department. Moreover, the relevance of ESCS policy-related research is improved by close association with the political realities experienced in the close association with the Secretary's office. The subcommittee feels that the source of the problem lies in the general strength of the staff relative to the many mandates from Congress and assignments from elsewhere. The subcommittee also agrees with the recommendation that additional social sciences should be represented on the ESCS staff, but not at the expense of replacing current programs without full weighing of the consequences.

With respect to the funding of research, the WFNS recommends

> ...substantial increases in federal funding for the traditional USDA research programs (including support for state programs), and we recommend funds to establish a new program of competitive grants for research on food and nutrition (p. 135).

The subcommittee concurs with this recommendation. However, the subcommittee recommends establishing a funding policy and process that assures adequate support for institutional maintenance. This process should be designed to maximize the complementarity between the grants programs and the institutionally supported programs.

The WFNS offered the following specific plan for the increased funding:

> We recommend a first-year increase on the order of $120 million, something under 20 percent of the total of about $700 million of USDA and state funds now devoted to food and nutrition research. We propose that the new funds be divided equally between existing federal-state channels and the new competitive grants program. Thereafter, we recommend successive increases, after adjustments for inflation, on the order of $60 million or approximately 10 percent per year in real terms for the next four years, also divided evenly between the existing programs and the new competitive grants program (p. 136).

The subcommittee believes the proposed high levels of funding probably could be absorbed because of "starvation" level support for current programs. However, the political feasibility of seeking such increases must be considered. Current political climate is not particularly favorable to "new" expansive efforts that are not associated with reduction in "old" programs.

Many food and nutrition studies over the past decade have emphasized the need for great expansions in expenditure on publicly supported R&D while high officials in the Executive Branch still do not see agricultural R&D as a need requiring significant increase in funding. The problem may be that a really strong case has never been made that foreign agricultural involvement is really important to U.S. concerns.

The WFNS made the following recommendation related to non-Federal research facilities and equipment:

> We recommend a five-year federal matching grants program for nonfederal research facilities and equipment. These grants should be available to other universities and private nonprofit institutions as well as those in the land-grant group. (p. 138)

The need for a matching grants program for non-Federal research facilities and equipment has been documented by previous study and supported by previous recommendations by ARPAC. However, there are some features of the current proposal that the subcommittee believes should be discussed thoroughly.

First, the Food and Agriculture Act of 1977 has mandated a study of facility needs of the traditionally supported institutions. Present recommendations probably should not anticipate this study's findings.

Second, grants for facilities to non-land grant institutions have not been a feature of agricultural grants programs in SEA or ESCS. Such grants carry implications of continued support that are contrary to the spirit of the competitive grants program outlined elsewhere in the WFNS. An alternative should be explored, possibly by use of allowances within the competitive grants program for facilities and equipment.

2. Recommendations relating to AID: The WFNS made five major recommendations. The subcommittee's reaction to each follows:

The study recommends "...a larger and more systematic effort...to help the developing countries establish research and development capabilities for food and nutrition in both the natural and social sciences." (p. 140) The subcommittee considers this recommendation to be consistent with our understanding of needs.

The study recommends "...a larger and better-designed AID effort to train research personnel for the developing countries." (p. 141) The subcommittee endorses this recommendation. Since this matter is an appropriate subject for Title XII activities, the existing arrangements are presumed adequate to achieve the desired degree of participation by Federal-State agencies. The subcommittee also recommends that the use of "international universities," including the "U.N. University," be considered as a means to facilitate training of foreign research personnel.

The study recommends "...the establishment of a joint AID-university committee on international training under Title XII of the Foreign Assistance Act." (p. 142) The subcommittee understands this charge has been given to the Joint Committee for Agricultural Development under Title XII.

The study recommends "...continuation of AID support for international research centers and programs..." (p. 142). The subcommittee endorsed this recommendation in its earlier discussion on the role of international centers.

The study recommends "...that AID enlarge significantly its support for establishing operating relationships between U.S. research groups and those in developing countries." (p. 143) The subcommittee favors this resolution and believes AID has a major, but not exclusive, role in developing the desired relationships.

3. Recommendations for NIH: The WFNS made three recommendations relating to the NIH (p. 145). Since these relate mainly to internal management problems and to funding of NIH, the subcommittee had no specific reaction to record. However, the subcommittee does call attention to some possible conflict between the implied role of NIH in nutrition research and that outlined in the Food and Agricultural Act of 1977.

4. Recommendations for NSF: The WFNS recommended the NSF "substantially increase its support of fundamental research in biology and other natural science disciplines underlying work on food and nutrition," strengthen its support for "disciplinary research in the social and behavioral sciences," increase size and duration of individual project duration, take "vigorous action" under its mandate to promote international scientific collaboration, and, finally, launch a program of training in interdisciplinary research.

The subcommittee believes these proposals are appropriate and reasonable. There appears little potential for conflict or interaction with existing USDA-State research units from implementing these recommendations. There could be an exception in the instance of the NSF support for work in biological science, but administrative means are already in place and apparently functioning satisfactorily to avoid duplication and to stimulate complementarity between the NSF and USDA grants programs. The subcommittee does sense a need for some mechanism whereby NSF can be informed of problems of a fundamental nature that arise in the conduct of applied research by the USDA-Land Grant system.

The subcommittee does have some minor misgivings regarding the conduct of training in interdisciplinary research. The subcommittee considers the present state of knowledge applicable to the conduct of interdisciplinary research is not well enough advanced to support a good training program. However, a useful session may be held with the objective of training to avoid past errors. More research is needed in this area, and NSF may be the appropriate agency to sponsor it.

5. Recommendations for Privately Supported Research: The WFNS recommended that both AID and USDA consider the use of private firms to conduct research when this was found to be cost effective (p. 149).

The subcommittee endorses this idea and makes the following observations. Private firms will be able to compete on equal footing with public competitors in the grants program. Some subcommittee members have had experience dealing with private firms that are not specialized in research and have found them to be, as the WFNS suggests, eager to become involved in research of a rather basic nature. This is a means, as viewed by private firm management, of keeping their research staff abreast of current developments.

The subcommittee is aware that some contracting of the nature recommended does take place. It is not aware of any particular problems associated with such contracting.

With the view toward facilitating greater involvement of private firms in the food and nutrition area, the WFNS recommends: "...that coordination and simplification of regulations affecting research...on food and nutrition be given early attention" and that "an early evaluation of U.S. and international proprietary rights" be made. (pp. 149-150) These recommendations are directed toward the Executive Office of the President.

The subcommittee can only attest that the problems are real and, if a solution is to be found, it will be at the Executive or congressional levels.

6. Recommendations related to the Executive Office: The WFNS recommends two new entities for the Executive Office of the President. One of these would "develop and maintain a coherent U.S. strategy for dealing with world food and nutrition problems." The other entity would "facilitate coordination of U.S. and international research activities on food and nutrition." (p. 151)

The complexities in formulating food and nutrition policy require the broadest involvement of interested parties in the process. The proposal for Executive Office level attention is one way of obtaining this involvement.

However, the subcommittee believes the Federal subcommittee on Food and Renewable Resources related to the charge to the Secretary of Agriculture, supported by the "Board" and the "Council," in the Food and Agriculture Act of 1977 can meet the objectives established for the first entity.

Further, the subcommittee believes that the function proposed for the second Executive Office entity in the WFNS can be carried out by the Secretary of Agriculture under the Food and Agriculture Act of 1977.

H. *Policy and Organizational Issues for ARPAC Attention.*

The subcommittee believes that most of the proposals in the WFNS are consistent with the aims and objectives of the USDA-State research units. Therefore, no specific response to most of the proposals is needed. The subcommittee has identified the following issues for specific response.

First, there is need to define and to document the role of agencies in research and training programs related to international food problems. The range of needed policy statements includes the following:

> --What rules shall govern coqperation in the international research arena when there is reason to believe the U.S. will gain from this cooperation? (Related to this is the question of the restrictions placed on use of Hatch funds in foreign countries.)
>
> --What rules shall govern coqperation when the U.S. interest is not obviously served?

--To what extent can the publicly supported agencies cooperate in international research when there is reason to believe the results may work to the commercial disadvantage of U.S. producers?

Second, the Food and Agriculture Act of 1977 mandates a research information system. The WFNS recommends such a system as well as a broader effort to bring into the system information on the current status of resources, nutritional and so forth. Questions that usefully may be addressed include:

--What are the roles of the various research units in developing and implementing this system?

--Is the merging of bibliographic facilities of SEA and FAO to be encouraged? How are they to be financed? In what time frame? Should AGRICOLA be replaced ultimately by the FAO-sponsored AGRIS?

--What are the roles of the various research units in the international effort currently to inventory resources, nutritional status, and food production?

Third, the absence of a coherent U.S. policy on food and nutrition, trade in agricultural commodities, and food reserves has been a longstanding problem that was reviewed in some detail in the WFNS. Questions of relevance include:

--What should be included in a domestic food policy?

--What are the important relationships to other areas such as foreign trade?

--What information flows and enforcement powers are required to implement and monitor a food policy?

--What mechanisms are needed for dealing with conflicts that will inevitably center on the food policy?

--What is the role of publicly supported research units in developing a setting in which such policies can be rationally elaborated?

Fourth, the WFNS noted that food and nutrition policy in foreign countries, primarily developing countries, was a serious barrier to solution to the world's food problems. Employees of the publicly supported research units represent a very large proportion of the food policy research capacity of the world. Do they have particular obligations to help solve these problems?

Fifth, an implied assumption in the WFNS is that the Executive Office, OMB, the Congress, and the public are aware of a serious world food problem and are committed to its solution. Experience gives only limited support to this assumption. Given that there is, in fact, a world food and nutrition problem, what are the dimensions of an effective program for making this fact effectively known to those who have the power to alter events?

Sixth, a part of the problem of obtaining support for food and nutrition research may be the lack of clear evidence that there exists the institutional framework within which an effective program can be carried out. Apparently the attacks on the "agricultural research establishment" of recent years, while largely unfounded, have been listened to and believed by some influentials. What can be done to:

--Commit publicly supported institutions, especially the Land Grant portion, to a firm plan of activity?

--Demonstrate the capacity of personnel in publicly supported institutions to do the needed work? Dispel the notion that personnel are capable of only mundane, repetitive, highly applied research?

--Demonstrate commitment to support work in international agriculture?

--Demonstrate capacity to mobilize resources outside the "establishment" for work on fundamental research problems?

Seventh, the world is without effective international leadership needed to direct and focus food and nutrition research. Who should take the lead?

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